**WORKSHOP: MICROPHONE SELECTION AND TECHNIQUE**
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presented by the Film Study Center at Harvard University

All microphones are *transducers* – devices that receive a signal of energy in one form (generally, acoustic) and convert it to another form (electric)

**Transducer Varieties:**

- ***Condenser (small or. large-diaphragm)***: Capable of capturing very subtle and quiet sounds but requires power to function. Larger diaphragms capture more acoustic energy requiring less amplification, but with more pronounced coloration, increased proximity effect. Smaller diaphragms produce more accurate sound and can be used in broader range of applications.
- ***Dynamic (moving-coil)***: Generally cheaper to produce and more durable than condenser mics. Requires more acoustic energy to function but less prone to feedback in live settings as a result. Needs no additional power.
- ***Piezoelectric (contact mic, hydrophone)***: Converts physical vibrations to electrical energy. Requires direct contact or a sound transmitted via a fluid conductor.
- ***Magnetic (coil) pickup***: Converts electromagnetic energy into electrical energy – used in electric guitar pickups

**Polar (pickup) patterns:**

- ***Omnidirectional***: Picks up sound equally from all directions. No proximity effect. Least coloration. More susceptible to feedback in live settings.
- ***Subcardioid***: Slightly more directional than omni mic with some attenuation at rear.
- ***Cardioid***: Unidirectional – Most sensitive at front and least sensitive (null) at rear. May exhibit off-axis coloration
- ***Supercardioid***: More directional than cardioid but with rear lobe of sensitivity and two null points
- ***Hypercardioid***: More directional than supercardioid but with a larger rear lobe
- ***Bi-directional (Figure 8)***: picks up sound evenly from front and back while rejecting sides. Most proximity effect.
- ***Lobar (shotgun)***: Extremely directional. Super- or hypercardioid with the addition of an interference tube that cancels off-axis sound. Length of tube is directly proportional to amount of side rejection. Most directional in higher frequencies (true of all mics).
- ***Parabolic***: Used with omni or cardioid capsules. Sonic equivalent of a telephoto lens. Parabola amplifies on-axis sound while reflecting away off-axis sound. Clear coloration often requires equalization in post.

- ***PZM (Boundary)****:* An omni or subcardioid mic is placed flush with a flat boundary eliminating reflected sounds and phase cancellation issues (e.g. the comb-filtering effect). Makes a good room mic when placed against a wall.

**Stereo configurations and arrays:**

- ***A/B (Spaced pair)***: Two microphones (often omnis) spaced at a distance and facing the same direction. Results in unnatural sounding stereo image due to difference in time it takes for a sound to reach each mic. Cannot be easily downmixed to mono.
- ***X-Y (Coincident pair)***: Two directional microphones are placed 90° from one another so that the capsules overlap (Sound arrives at the same point). Creates a natural sounding stereo image with little depth. Can be downmixed to mono with minimal issues.
- ***Mid-Side***: A forward facing unidirectional microphone is placed coincident with a sideways facing bi-directional microphone. The sides are created by inverting the phase of one channel. The width of the stereo image can be shaped by varying the amount of the side channels in the mix. Fully mono compatible.
- ***Binaural***: Two microphones spaced the same distance as human ears, often using a dummy head, to mimic how we actually hear. Creates hyper-realistic stereo recordings when played back on headphones.
- ***Ambisonic***: A three-dimensional extension of the M/S technique which captures a full 360° soundfield using four or more microphones. Must be decoded to the whatever speaker / playback configuration is desired. Good for VR.
- ***5.1 Surround***: Five microphones positioned in an array that will create a surround-sound ready mix of a field recording.

**Accessories:**

- ***Shock mount***: Prevents handling noise
- ***Mic stand***: Holds a microphone at desired height and angle
- ***Boom pole***: Helps get mic as close as possible to subject without being in shot
- ***Foam windscreen***: Limits wind noise and helps protect mic in case of fall
- ***Fuzzy windscreen ("dead cat")*** More effective than foam windscreen but requires periodic grooming
- ***Zeppelin / Blimp***: Creates a pocket of static air around the microphone to reduce wind noise
- ***Pop filte***r: Functions similarly to windscreen to attenuate the energy of plosives. For studio use only.

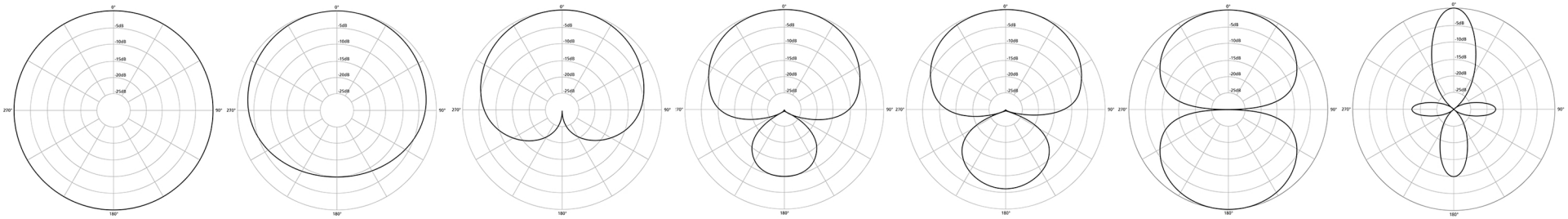
**Technique and practice / Considerations:**

- ***Choosing a mic***: Consider polar patterns, frequency response curves, mic sensitivity, and design specifics for a given recording environment (e.g. humidity resistance w/ Sanken CS-3e)
- ***Proper handling***: Always isolate from wind and vibrations as best as possible. Cables can transmit vibrations too.
- ***Placement***: Close miking results in less reflections and a “dryer” sound with more clarity. Distant miking results in more reflections / ambience. Recording with both simultaneously allows for a mix that is both clear and natural sounding.
- ***Impedance matching***: Modern microphones are all relatively low impedance, and recorder or mixer inputs are produced to match this. Piezo elements are very high impedance, and must be matched to the inputs by means of a buffer circuit for the best sound.
- ***Line level vs. mic level***: Mic level is 40-60dBV lower than line level. Sending line level to a mic level input will overload it and cause distortion. Mic level into line level will produce a very weak signal and introduce preamp noise when boosted.
- ***Phantom power (+48V), T-power (+9-12V), plug-in power (+3-5V)***: Condenser mics require power to function. Make sure you are applying the correct voltage. Do not send phantom power to microphones or other equipment that is not expecting it as it can do damage to the equipment.
- ***Attenuation***: If your signal is too “hot” due to a loud environment, use an attenuator or pick a less sensitive microphone.
- ***Proximity effect***: Directional mics emphasise low frequencies at close proximity to sound source. Can make recordings sound “warm” but also “muddy”. This can be remedied by placing more distance between microphone and subject or by using a low-cut filter. Proximity effect can also be used to positive creative effect.

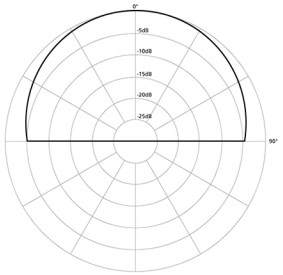
**Frequency response:**

- Humans are capable of hearing sounds from approx. 20Hz to 20kHz with most sensitivity in the 2kHz to 5kHz range
- The human voice occupies a range of approx. 70Hz to 10kHz with the consonants in non-tonal languages predominantly found in the 2 kHz-4 kHz frequency range.
- Sub bass range of 20 - 60Hz can be heard but is difficult to place spatially (almost felt more than heard)

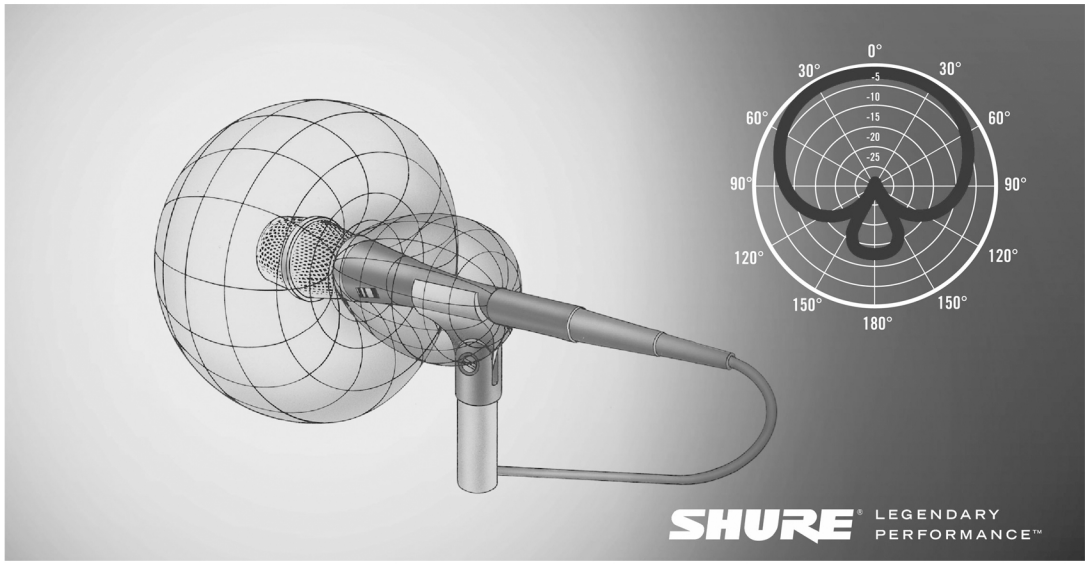
# POLAR PATTERNS

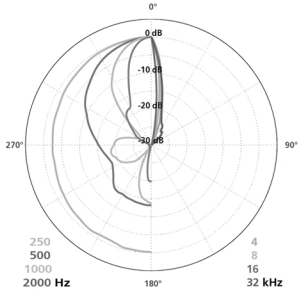


Omnidirectional | Subcardioid | Cardioid | Supercardioid | Hypercardioid | Bi-directional | Lobar



Boundary




Parabolic